The Importance of Season in the Testing of Radon using Short-Term tests in Residential Structures, Portland, Oregon

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Abstract

Radon has been identified by the U.S. EPA as the second leading cause of lung cancer. Radon gas exists naturally at low levels. When the gas becomes concentrated in living spaces, a health hazard arises. The most recent radon risk assessment for Portland, Oregon was performed in 2013. For the first time the 2013 analysis included long-term and short-term (3-7 day) tests. Access to this new short-term radon data allowed for analysis based on season. Season was defined for the climate of Portland, Oregon as tests ending: winter (October 1-March 31), summer (June 1-August 31), and swing (March 1-April 31 and September 1-30). A total of 14,873 indoor residential structure readings were analyzed, defining 66 zip codes with one or more seasonal radon potentials. Both overall and within season zip code radon data were examined for maximum radon reading, average radon reading, and percent greater than 4 pCi/l, which combine to determine the radon potential. Statistical t-tests were also performed to determine significance. Based on the analysis of all seasonal short-term radon testing, winter tests result in statistically significantly higher readings than tests in summer or swing months. No significant difference was found in tests between summer and swing months. Winter short-term radon potential most closely parallels overall short-term radon potential for individual zip codes (89% agreement). Short-term tests are not good indicators of long-term test results (<66% agreement). If a short-term test is necessary, a winter season test is suitable. These data support current EPA guidelines regarding radon testing.

Radon Facts

- Radon-222 is a colorless, odorless, naturally occurring gas
- Radon has been know to be a health hazard since 1984
- Radon gas is the second leading cause of lung cancer overall and the leading cause of lung cancer among non-smokers
- Radon-222 gas comes from the radioactive decay of uranium-238 and is the only gaseous daughter product
- Radon-222 has a half-life of 3.8 days
- Average outdoor radon level is 0.4 pCi/l
- Average indoor radon level is 1.3 pCi/l
- The U.S. EPA has defined the action level for indoor radon at 4.0 pCi/l
- The U.S. EPA estimates 1 in 15 residential structures in the country has high radon levels
- Studies of the Portland, Oregon Metro area have estimated as high as 1 in 3 residences having high radon levels

Results

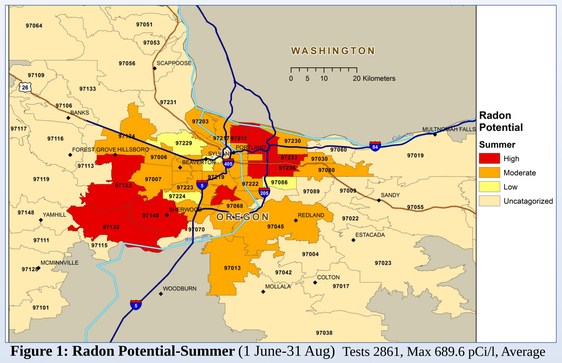

Figure 1: Radon Potential-Summer (1 June-31 Aug) Tests 2861, Max 689.6 pCi/l, Average 3.8 pCi/l, %>4 pCi/l 26%. A total of 45 zip codes were categorized: High n=13 (29%),Moderate n=27 (60%), Low n=5 (11%)

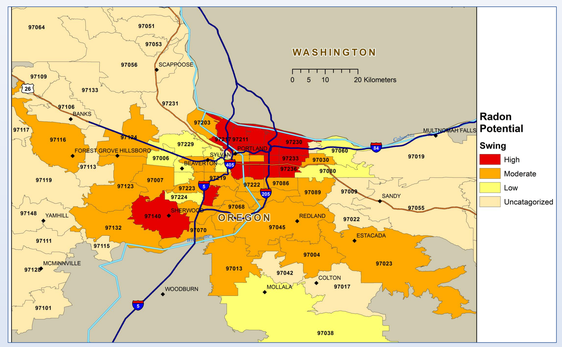

Figure 2: Radon Potential-Swing (1 Apr-31 May and 1-31 Sept) Tests 4045, Max 110.4 pCi/l, Average 4.0 pCi/l, %>4 pCi/l 31%. A total of 56 zip codes were categorized: High n=16 (29%),Moderate n=28 (50%), Low n=12 (21%)

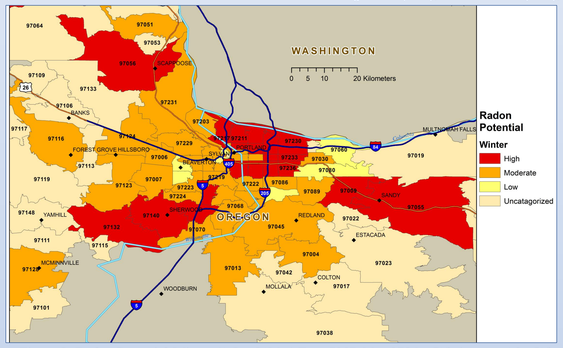

Figure 3: Radon Potential-Winter (1 Oct-31Mar) Tests 7967, Max 976.2 pCi/l, Average 4.8 pCi/l, %>4 pCi/l 35%. A total of 62 zip codes were categorized: High n=19 (31%),Moderate n=34 (55%), Low n=7 (11%)

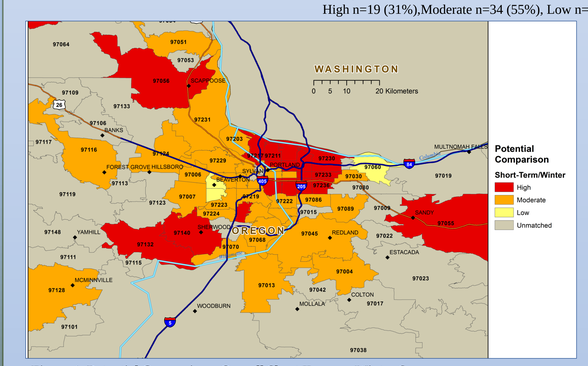

Figure 4: Potential Comparison- Overall Short Term vs. Winter Season

Of the 62 winter zip code potentials 55 are the same as Linde et al. 2013 overall zip code radon potentials (89%).

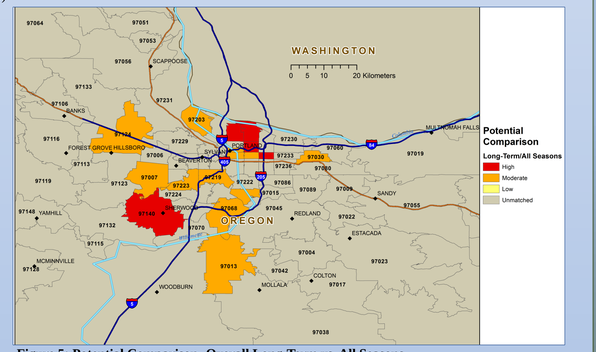

Figure 5: Potential Comparison- Overall Long-Term vs. All Seasons

Of the 74 long-term zip code potentials from Linde et al. 2013 only 15 zip code radon potentials are continuous through all three seasons and long-term tests (20%).

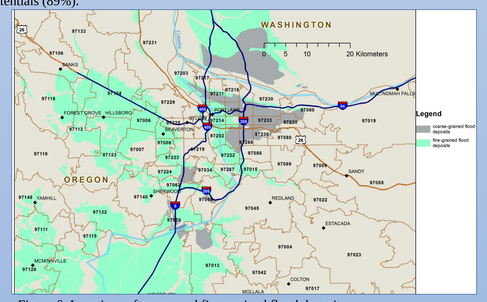

Figure 6: Locations of coarse and fine-grained flood deposits

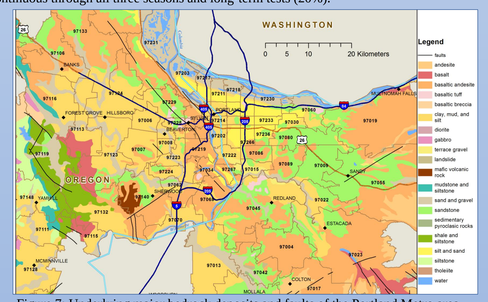

Figure 7: Underlying major bedrock deposits and faults of the Portland Metro area

Methods

Season was defined by the climate of the Portland Metro area

Winter Season was defined as all short-term tests ending between
1 October-31 March
Summer Season was defined as all short-term tests ending between
1 June-31 August
Swing Season was defined as all short-term tests ending between
1 April-31 May and 1-31 September

Radon Potential

	Max	Rank	Average	Rank	%> 4 pCi/l	Rank	Rank Sum=Potential*
High	>10 pCi/l	3	> 4pCi/l	3	>35%	3	**9-8**
Medium	4-9.9 pCi/l	2	2-4 pCi/l	2	16-35%	2	**7-5**
Low	<4 pCi/l	1	<2 pCi/l	1	<16%	1	**4-2**

*If a season within a zip code had less than ten records available, the risk potential was left uncategorized for that season.

T-tests

Datasets were determined to be significantly different if the number of tests within the set was ten or greater and significance was 0.05 or less (95% confidence). T-tests were performed for overall season significance as well as within each zip code.

Conclusions

- Winter has significantly higher indoor radon readings than both Summer and Swing (Figures 1-3).
- Summer indoor radon readings are not significantly different from Swing (Figure 1-2).
- Season of testing for indoor radon is a significant factor in the result of the test.
- Winter season short-term tests are a good analogue for the overall radon potential for an individual zip code (Figure 4).
- Long-term radon potential was not closely paralleled by any season which indicated that long-term tests should still be favored to produce the most accurate radon reading (Figure 5).
- Due to highly variable geology, soil properties, and construction types, every residential structure should be tested for radon (Figures 6-7).
- When a residential structure is tested (long-term or short-term) as much as possible of the winter season for the area should be included.
- The definition of seasons will vary from location to location due to climate.

References

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